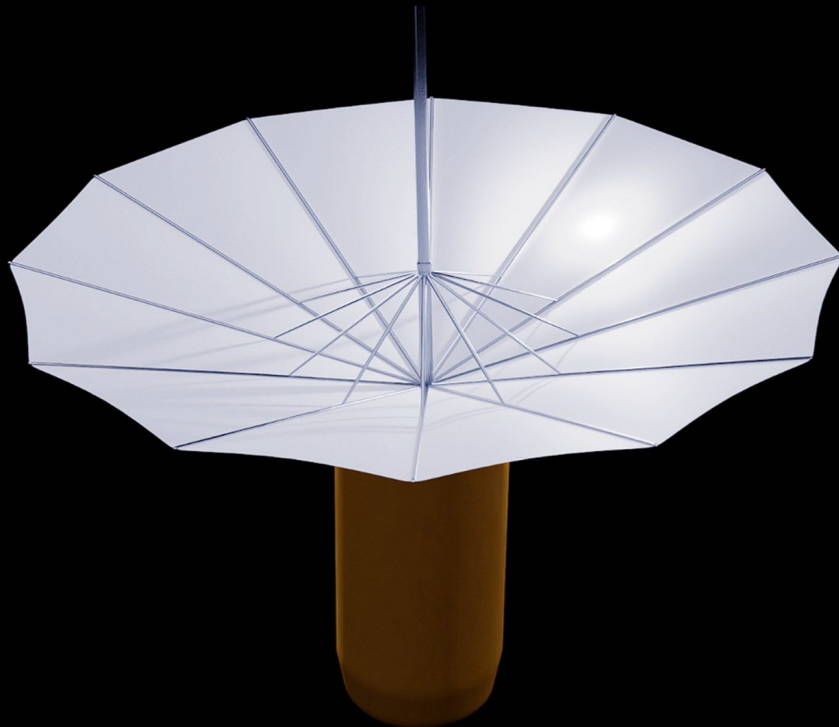


ALBEDO FARMS

Abstract

A project which consists in increasing the terrestrial albedo to deceive nature into perceiving that there is an artificial ice age underway, bypassing the Milankovitch cycles. The final aim is to reflect solar radiation back into space and allow glaciers to strengthen and over time to bring them back to their natural dimensions, consequently lowering the global temperature to pre-industrial temperature levels, curb sea level rise worldwide and stabilize average ocean temperatures. By installing albedo farms over a working area of between 20% and 36% of the ocean surface, to reflect solar radiation as the main task, while in the meantime producing electricity thanks to the solar panels of the albedo farms as a secondary task, to then sell this electricity and refund the cost of the project.



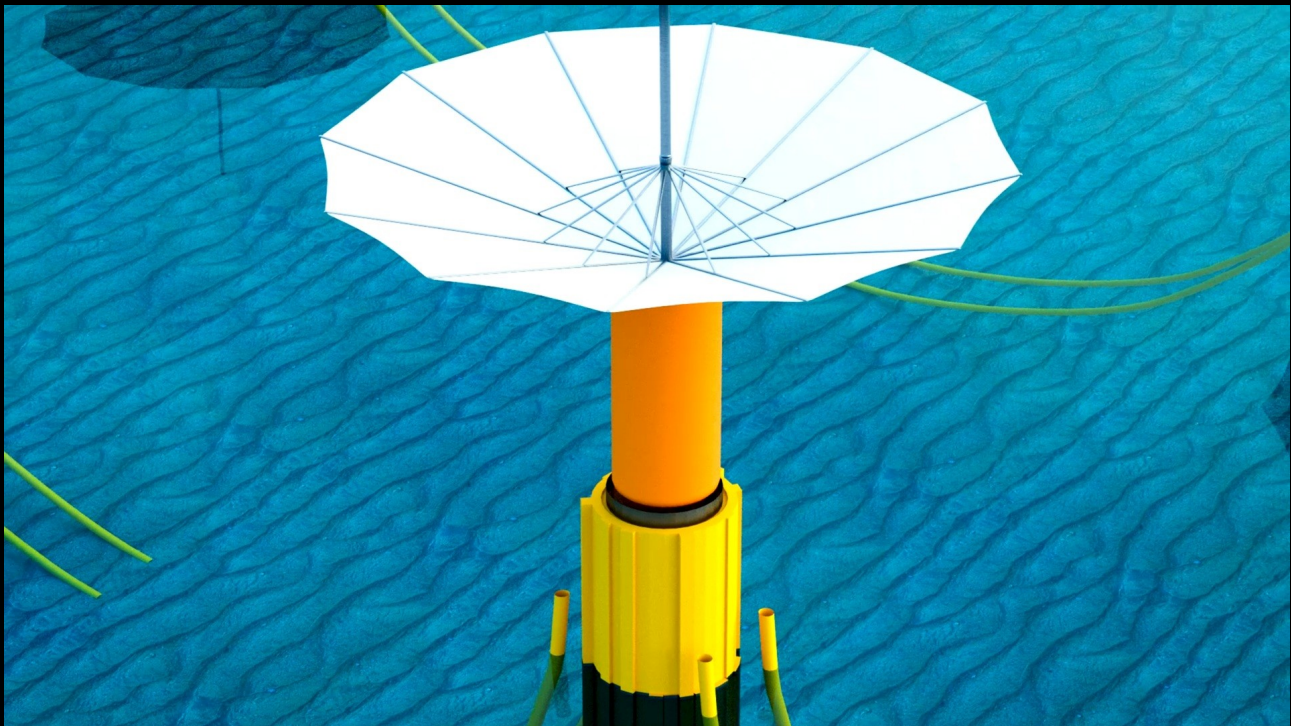
Introduction

Floating bases

Albedo farms are made up of a fixed part, which consists of the base and a modular part which is installed above the base and which can be replaced if necessary. The floating base is rubber coated to slow down oxidation. It floats on the water thanks to a ballast system and is anchored to the ocean floor, where the power grid is also located. For anchoring, it is possible to use existing anchors for offshore oil rigs or wind farms, depending on ocean depth. To have a farm that is less intrusive with the marine ecosystem, it is possible to opt for platforms semi-submerged in the water, similar to offshore oil platforms, which can mount four or more modular sections. It will not be necessary to anchor all the platforms to the ocean floor. Only the master platforms will be secured directly to it and connected to the power grid, while the satellite platforms will be connected to the master platform on the water surface.

Modular section

The modular section consists of a vertical tube from which solar sails are deployed and are shaped like an umbrella when fully unfolded. The umbrella shaft will be approximately as long as the length of the tube, so the opening of the umbrella will have a radius similar to the height of the tube. In a scenario with a 100 meter long tube, the design allows for a shaft of approximately the same length, with a circumference of approximately 628 meters and finally, the fully unfolded umbrella will cover an area of approximately 31,400 square meters. But without knowing in advance the necessary materials and the technological limitations, this type of scenario can only be inferred given current technological constraints.

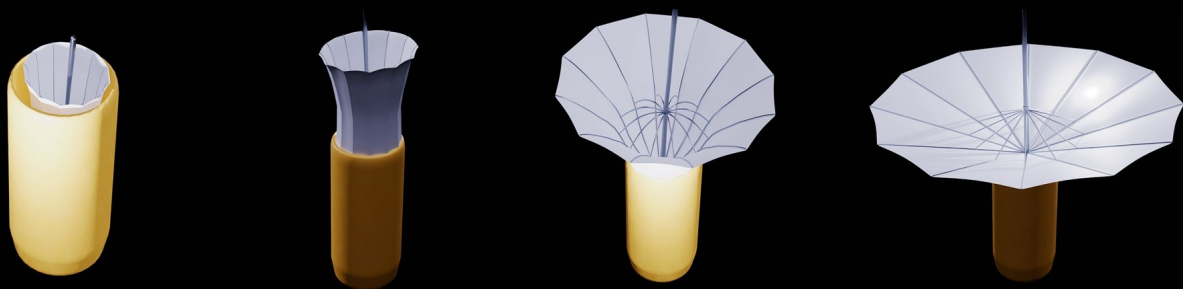


Opening phases

The modular section is composed of three segments.

- A mechanical segment that opens and closes the umbrella depending on weather conditions.
- An electronic segment (the inverter) that converts direct current into alternating current and from an emergency battery.
- A mobile segment made up of solar panels and the various sensors necessary to monitor the module.

The GPS signal, the system for monitoring the height and period of the waves, pressure sensors and a weather station can be installed on the master platform, to monitor weather conditions in real time and close umbrellas in case of bad weather. The system can self-manage or be controlled remotely via satellite internet, wireless mesh network and cable internet. Umbrellas may also close during certain times of day to allow for natural light cycles, balancing reflectance with biological health.



Coral reef

The seas of tropical regions, in which the water temperature is around 25°C, constitute an ideal environment for madrepores. Corals need an average water temperature of 25°C (higher than 20°C during winter), constant salinity and lots of light, therefore albedo farms cannot be installed in areas where coral reefs are found. The main coral reefs are found in the waters of the western Atlantic Ocean and the Indo-Pacific between the latitudes of 30°N and 30°S. The main cause of the destruction of coral reefs (the bleaching) appears to be the ever-increasing temperature of the oceans. In 1998, the passage of El Niño increased the average temperature by 2°C, caused the death of around 90% of the coral in some areas of the Indian Ocean. In 2023 the temperature of the Atlantic Ocean in southern Florida reached 38.33°C and risks endangering the coral reef in that area. But this does not prevent safeguarding the natural habitat of coral by using albedo farms. Thanks to the wide distribution of albedo farms in other ocean regions, an artificial shadow will be created that can lower the average temperature of the oceans and together with the electricity produced by the albedo farms, the adoption of albedo farms enables a gradual phase-out of fossil fuels and further lowers the global average temperature.

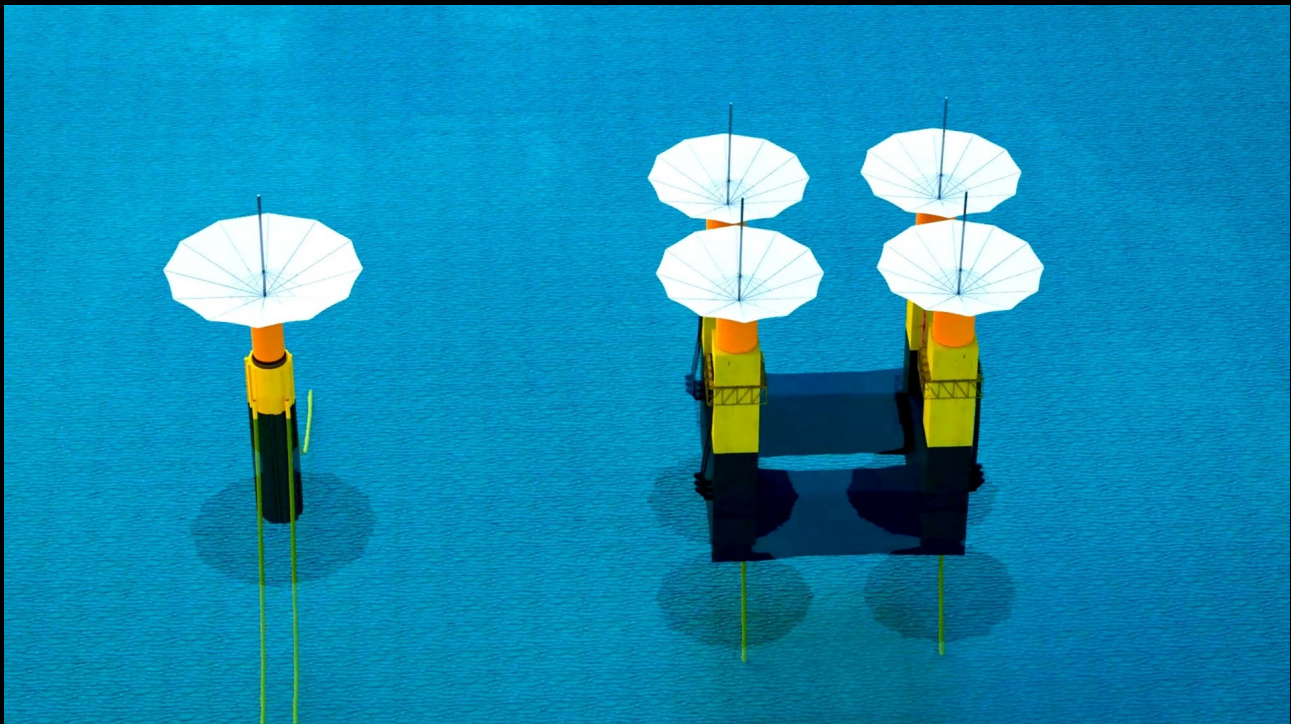
Animals and insects

In addition to corals, many animals and insects are in fact at risk due to the increase in temperature, the reduction of precipitation, the melting of the glaciers, sea levels rise and various types of pollution. Among these insects there are also bees, they too are stressed by the increase in temperature. While adult bees are able to tolerate temperatures up to 50 degrees, younger bees and drones need lower temperatures to survive (32-35 degrees). It is a problem for biodiversity, given that these precious insects play a fundamental role in maintaining ecological balances and in pollination, both of wild plants and those of commercial interest.

Approach

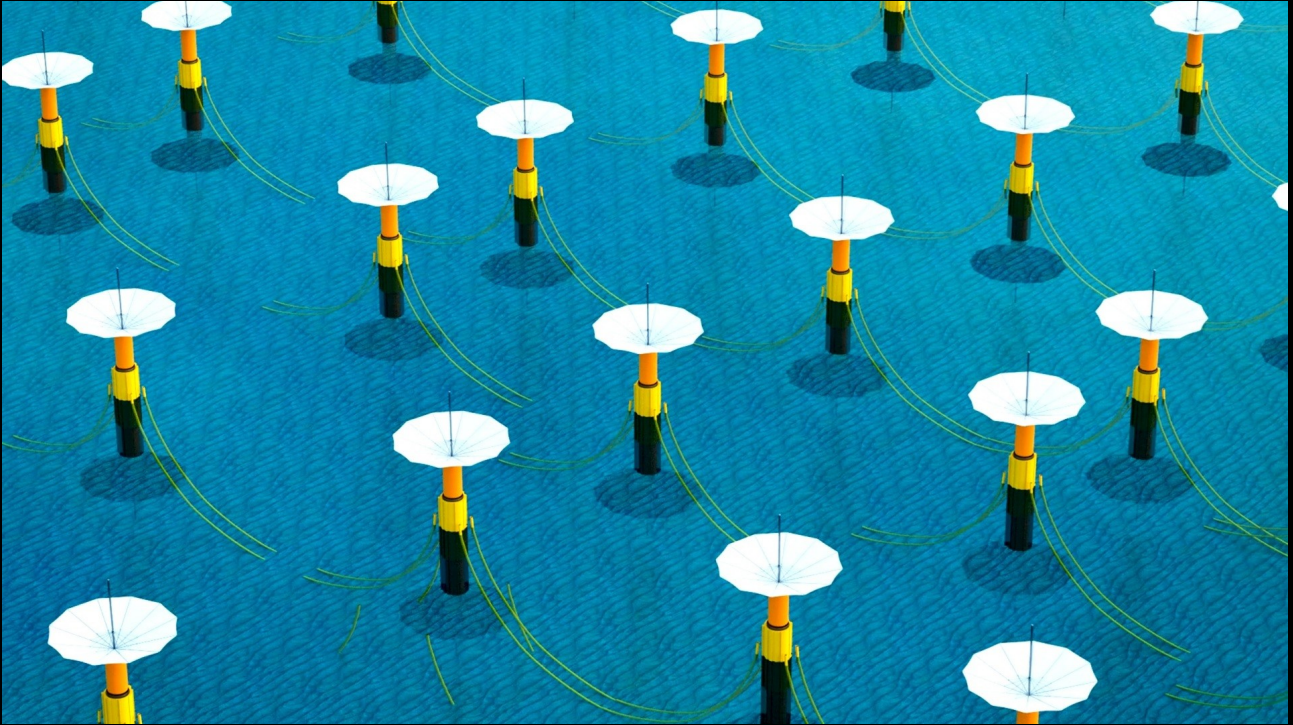
Solar radiation

The umbrella sails are made of transparent solar panels on a white support to imitate the natural color of snow (albedo 0.70), this color serves to reflect solar radiation (future modules may incorporate electrochromic solar panels to adjust terrestrial albedo remotely via electrical impulses). To keep solar panels clean, a combination of solar panel inclination (while the umbrella is closed) along with the electrodynamic screen (EDS) could be used. The main task of solar panels is to reflect solar radiation, while the secondary task is to produce electricity on a large scale. Electricity will be transported to the mainland via a massive power grid located on the ocean floor, to then be stored in the energy storage system (ESS) and finally distributed across all continents. It is necessary to rethink the entire power grid because the current copper cable network would not be able to sustain such an enormous flow of electricity.



Energy storage

Intermittent sources such as the sun, produce intermittent power, in this case, energy storage becomes necessary to make a stable and reliable energy supply available, including the switch between day and night. Due to the imbalance between energy consumed and energy produced by albedo farms, an accumulation of energy is necessary to achieve higher levels of energy self-sufficiency. Furthermore, energy storage allows the creation of energy arbitrage, a necessary practice for the electricity suppliers to whom this energy will be sold, who in turn will sell to the final consumer.



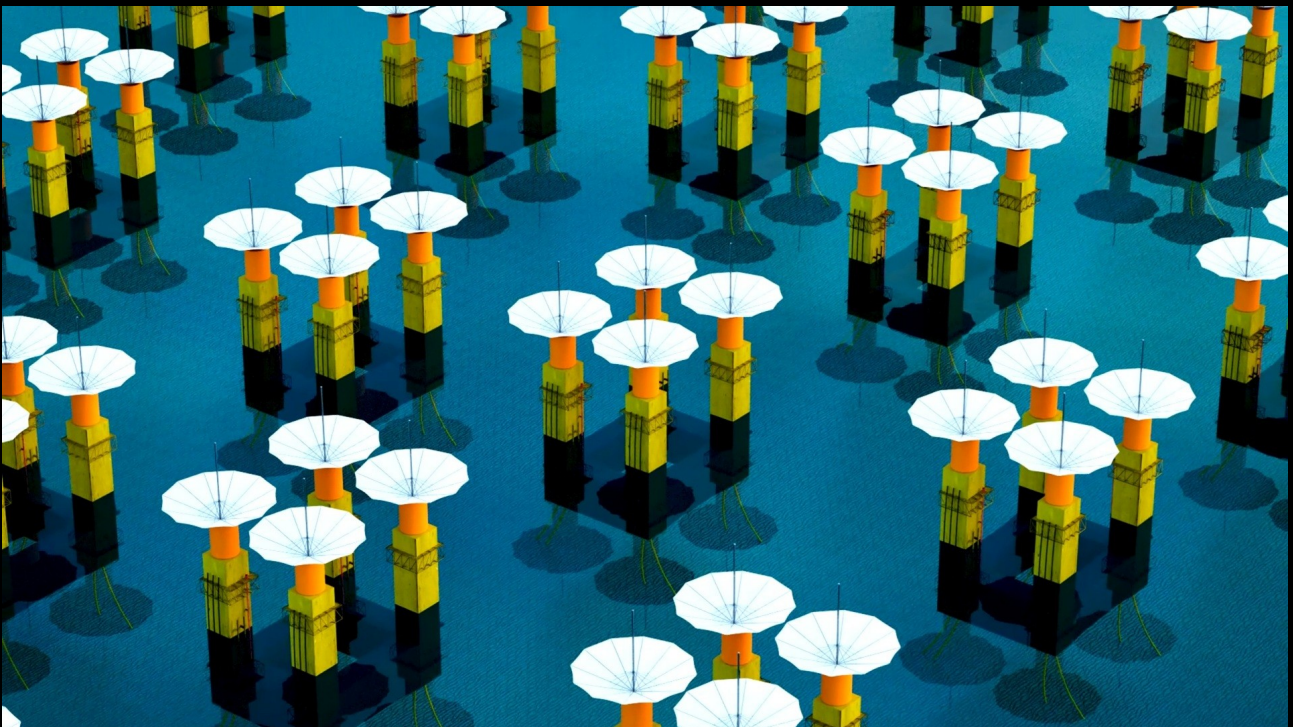
Methods

Marine ecosystem

Why on the ocean surface and not on the mainland?

- On the mainland, it would be more rational to plant trees wherever possible.
- The desert area on the Earth (Erg) is not big enough to hold the dimensions of this project, only the ocean surface is large enough to hold a project of this size (about 132 million square kilometers).
- Installing albedo farms in the desert would not be very productive, because the albedo of sand can reach up to 0.40, while the albedo of the oceans reaches up to 0.10. Accordingly, replacing the albedo of the sand with the albedo of solar panels would further increase the surface area required for the workspace.
- Installing white solar panels in cities would not be enough to change the terrestrial albedo, the world's urban built-up area is approximately 1.5 million square kilometers.
- There are various bureaucratic issues that every nation would have to encounter, while in international waters they would be null and void.
- There is the problem of borders, installing albedo farms in the desert and then sell the electricity between various neighboring nations, this electricity could be easily converted into a geopolitical weapon, while on the ocean surface, albedo farms are not owned by a single nation, but by all the nations that participate in them.

From this scenario, the entire marine ecosystem will be artificially changed forever. As mentioned above, equatorial latitudes should be avoided to protect coral reefs and move away from the coasts, in the deep waters of the oceans, to protect phytoplankton.



Results

Working area

Taking into consideration the chlorophyll map, the coral reefs map, the underwater volcanoes map, the bathymetric map, if these four maps are overlapped, approximately 40% of the ocean surface is targeted as suitable for the albedo farms. Accordingly, some shipping routes and some FAO fishing areas will have to be modified and adapted to the new working area.

In the scenario with a 100 meter long tube, to maintain a safety distance between the floating bases and where the ocean floor allows it, the working area will be about 2.5 times larger than the required ocean surface. Should the global average temperature increase by 5 degrees Celsius by the year 2100 (Worst scenario SSP5-8.5), it would be necessary to cover more than 53 million square kilometers of the oceans by that time to allow reflectance to cancel out this temperature increase. In other words, this would require covering more than 14% of the oceans (without the safety distance). Meanwhile, the worked area of the whole ocean (including the safety distance) would constitute 36.6% of the total surface. Specifically, this equals 133 million square kilometers, representing more than a third of the usable ocean surface, which falls within the 40% workable limit mentioned above.

This will not be a sudden disruption to the marine ecosystem, but rather a gradual change spread over 74 years starting from 2026. The percentage of the ocean surface may change in the years to come, if the exact latitude of the working area is more precisely determined, the materials used, the size and shape of umbrellas, the increase or decrease of radiative forcing (greenhouse gases), avoid natural disasters, etc.

Decade	SST (°C)	ΔT (°C)	ΔF (W/m ²)	$\Delta \alpha_p$	A (Mio km ²)	P (%)	Wa (Mio km ²)	Wa (%)
1900	+0.00	+0.0	0.00	0.00	0.00	0.00	0.00	0.00
1910	-0.04	+0.1	0.12	0.10	1.09	0.30	2.72	0.75
1920	+0.01	+0.2	0.25	0.20	2.18	0.60	5.45	1.50
1930	+0.08	+0.3	0.38	0.31	3.26	0.90	8.15	2.25
1940	+0.12	+0.4	0.50	0.41	4.35	1.20	10.87	3.00
1950	+0.10	+0.6	1.15	1.01	6.53	1.80	16.32	4.50
1960	+0.14	+0.8	1.00	1.22	9.11	2.40	22.77	6.00
1970	+0.20	+0.9	1.12	1.32	10.19	2.70	25.47	6.75
1980	+0.32	+1.0	1.25	1.42	11.28	3.01	28.20	7.52
1990	+0.45	+1.1	1.38	1.53	12.37	3.31	30.92	8.27
2000	+0.58	+1.3	2.02	2.13	14.16	3.91	35.40	9.77
2010	+0.82	+1.5	2.28	2.34	16.35	4.52	40.87	11.30
2020	+0.95	+1.7	2.12	2.54	18.53	5.12	46.32	12.80
2030	+1.15	+2.2	3.15	3.45	24.37	6.62	60.92	16.55
2040	+1.40	+2.7	3.38	4.37	29.42	8.13	73.55	20.32
2050	+1.70	+3.2	4.00	5.28	35.27	9.63	88.17	24.07
2060	+2.05	+3.7	5.02	6.19	40.31	11.14	100.77	27.85
2070	+2.40	+4.0	5.00	6.50	43.48	12.01	108.70	30.02
2080	+2.75	+4.3	5.38	7.21	47.05	12.89	117.62	32.22
2090	+3.05	+4.6	6.15	7.51	50.22	13.76	125.55	34.40
2100	+3.30	+4.9	6.12	8.22	53.39	14.64	133.47	36.60

LEGEND

SYMBOL	DESCRIPTION	FORMULA
SST (°C)	sea surface temperature increase	Input data (°C)
ΔT (°C)	global temperature increase	Input data (°C)
ΔF (W/m ²)	negative radiative forcing	$\Delta F = \Delta T / 0.8$
$\Delta \alpha_p$	radiance reaching the ocean surface	$\Delta \alpha_p = \Delta F / 122.05$
A (Mio km ²)	targeted area (without safety distance)	$A = \Delta \alpha_p \cdot 0.67510$ (Million km ²)
P (%)	targeted area in percentage	$P = 362 \cdot A$ (%)
Wa (Mio km ²)	worked area (with safety distance)	$2.5 \cdot A$ (Million km ²)
Wa (%)	worked area in percentage	$2.5 \cdot P$ (%)

"Values based on SSP5-8.5 Scenario (High Emissions Pathway)"

Conclusion

It is up to the scientific community to move the Overton window to make this idea acceptable. This is not a commercial project, but it has the potential to pay for itself in the long run. Should it become possible to change the color of solar panels remotely (electrochromic solar panels), albedo farms should no longer be dismantled once they have completed their main task (reflectance), but the terrestrial albedo could be changed depending on the need. To start funding this project, it could be initiated through a global tax, or allocating a percentage of global GDP, or ask for loans from banks, but once the project is self-sustaining, it will be able to self-finance easily, because it will produce so much electricity to sell, more than all of humanity can consume.

This is a project where all the nations of the world can and must participate. This initiative represents a unified global commitment requiring the involvement of all nations, such a collaboration could provide a strategic diplomatic truce, demonstrating that collective stability and planetary health are more productive priorities than geopolitical friction. This collaboration will ensure a sustainable future and shared benefits for all participating nations.

